Disclosure No. 199-1883

TURBULATOR WITH OFFSET LOUVERS AND METHOD OF MAKING SAME

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to heat exchangers for motor vehicles and, more specifically, to a turbulator with offset louvers and method of making same for a heat exchanger in a motor vehicle.

2. Description of the Related Art

It is known to provide a tube for a heat exchanger such as an oil cooler in a motor vehicle. The tube typically carries a first fluid medium in contact with its interior while a second fluid medium contacts its exterior. Typically, the first fluid medium is oil and the second fluid medium is air. Where a temperature difference exists between the first and second fluid mediums, heat will be transferred between the two via heat conductive walls of the tube.

It is also known to provide corrugated fins or ribs in the interior of the tube to increase the surface area of conductive material available for heat transfer to cause turbulence of the fluid carried in the interior of

the tube and to increase the burst strength of the tube. One known method of making such a tube is to physically insert a corrugated fin into a generally flattened tube after the tube has been manufactured. This is an extremely difficult process since the corrugated fin to be inserted into the tube is extremely thin and subject to deformation during the insertion process.

It is also known to produce a corrugated fin or turbulator by a stamping process. An example of such a turbulator is disclosed in U.S. Patent No. 5,560,425. In this patent, the turbulator is made by stamping in a direction parallel to the fluid flow or strip direction of the turbulator and has corrugations in a direction perpendicular to the direction of the flow of the fluid or strip direction.

It is further known that a turbulator for a charged air cooler (CAC) may be formed by stamping as described above or by roll-forming corrugation, then with a secondary stamping for louvers. Although these methods have worked well, they suffer from the disadvantage that the stamping process does not have a high production through put. Another disadvantage is that the stamping process is relatively expensive. Therefore, there is a need in the art to provide a method of using only roll

forming to manufacture tubulators in a relatively less costly manner.

SUMMARY OF THE INVENTION

Accordingly, the present invention is a turbulator with offset louvers for a heat exchanger including a plurality of corrugated fins each having a base extending laterally and longitudinally in a strip. The turbulator also includes a plurality of offset louvers spaced along the base and extending longitudinally and generally perpendicular to the base in an alternating manner. The offset louvers are rolled in a direction parallel to a longitudinal axis of the strip.

In addition, the present invention is a method of making a turbulator with offset louvers for a heat exchanger. The method includes the steps of providing a generally planar strip having a base extending laterally and longitudinally. The method also includes the step of forming a plurality of offset louvers spaced along the base and extending generally perpendicular to the base in an alternating manner such that the offset louvers extend in a direction parallel to a longitudinal axis of the strip.

One advantage of the present invention is that a turbulator with offset louvers is provided for a heat exchanger such as a charge air cooler for a motor vehicle.

Another advantage of the present invention is that a method of making a turbulator with offset louvers is provided. Yet another advantage of the present invention is that the method of making the turbulator with off-set louvers uses only roll forming to manufacture the turbulators, which is less costly and increases production through put. Still another advantage of the present invention is that the method of making the turbulator with offset louvers uses roll forming to make turbulator corrugations and cut louvers simultaneously. A further advantage of the present invention is that the method of making the turbulator with offset louvers has the direction of roll forming the same as the strip or fluid direction.

Other features and advantages of the present invention will be readily appreciated, as the same becomes better understood, after reading the subsequent description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a turbulator with offset louvers, according to the present invention, illustrated in operational relationship with a heat exchanger of a motor vehicle.

FIG. 2 is a sectional view taken along line 2-2 of FIG. 1.

FIG. 3 is an enlarged partial perspective view of a portion of the turbulator of FIG. 1.

FIG. 4 is a side elevational view of an apparatus for making the turbulator of FIG. 1.

FIG. 5 is a front elevational view of the apparatus for making the turbulator of FIG. 1.

FIG. 6 is a sectional view taken along line 6-6 of FIG. 5.

FIG. 7 is an enlarged view of a portion in circle 7 of FIG. 5.

FIG. 8 is a perspective view of the turbulator made with the apparatus of FIGS. 4 through 7 before being folded into its final configuration of FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

Referring to the drawings and in particular FIG. 1, one embodiment of a heat exchanger 10 for a motor vehicle (not shown), such as a charge air cooler, oil cooler, evaporator, or condenser, is shown. The heat exchanger 10 includes a plurality of generally parallel tubes 12 extending between oppositely disposed headers 14,16. The heat exchanger 10 includes a fluid inlet (not shown) for conducting cooling fluid into the heat exchanger 10 formed in the header 14 and an outlet (not shown) for directing fluid out of the heat exchanger 10 formed in the

header 16. The heat exchanger 10 also includes a plurality of convoluted or serpentine fins 18 attached to an exterior of each of the tubes 12. The fins 18 are disposed between each of the tubes 12. The fins 18 serve as a means for conducting heat away from the tubes 12 while providing additional surface area for convective heat transfer by air flowing over the heat exchanger 10. It should be appreciated that the heat exchanger 10 could be used in other applications besides motor vehicles.

Referring to FIGS. 1 and 2, the tube 12 extends longitudinally and is substantially flat. The tube 12 includes a base 20 being generally planar and extending laterally. The tube 12 also includes a top 22 spaced from the base 20 a predetermined distance and opposing each other. The top 22 is generally planar and extends laterally. The tube 12 includes a first side 24 interposed between the base 20 and the top 22 along one side thereof. The first side 24 is generally arcuate in shape. The tube 12 also includes a second side 26 interposed between the base 20 and the top 22 along the other side and opposing the first side 24 to form a channel 28. The second side 26 is generally arcuate in shape. The tube 12 is made of a metal material such as aluminum or an alloy thereof and has a cladding on its inner and outer surfaces for brazing. It

should be appreciated that the tube 12 is conventional and known in the art.

Referring to FIGS. 1 through 3 and 8, the heat exchanger 10 includes a turbulator, generally indicated at 30 and according to the present invention, disposed within the channel 28 of each of the tubes 12. In the embodiment illustrated, the turbulator 30 extends laterally and longitudinally in the form of a strip 31 that is folded or corrugated providing a series of fins 32, between folds or connecting members 33. Each fin 32 of the turbulator 30 has a generally planar base 34 extending laterally a predetermined distance and longitudinally a predetermined distance between the connecting members 33. The base 34 has a predetermined thickness such as between approximately 0.05 millimeters (mm) to approximately 0.25 mm. Each fin 32 of the turbulator 30 also has a plurality of louvers 36 spaced laterally along the base 32 and extending longitudinally to turbulate fluid flow through the channel 28. The louvers 36 have generally inverted "U" cross-sectional shape. The louvers 36 are offset generally vertically from a plane of the base 32 and extend generally perpendicular to a plane of the base 34 a predetermined distance between approximately 0.3 mm to approximately 1.0 mm. The louvers 36 extend longitudinally a predetermined distance such as between approximately 4.0 mm to

approximately 11.0 mm in a strip or fluid flow direction. The louvers 36 are spaced laterally a predetermined distance between approximately 0.80 mm to approximately 3.0 mm. The louvers 36 also extend perpendicular to the plane of the base 34 in an alternating pattern such that one of the louvers 36 extends upwardly and a laterally adjacent louver 36 extends downwardly. The louvers 36 are spaced laterally in a row, which is offset from an adjacent longitudinal row of laterally spaced louvers 36 such that in a longitudinal direction one of the louvers 36 extends upwardly and the longitudinally adjacent louver 36 extends downwardly. The louvers 36 are formed by roll forming the strip 31 in a direction along its longitudinal length to be described. The turbulator 30 is made of a metal material such as aluminum or an alloy thereof and has a cladding on its surfaces for brazing the turbulator 30 to the tube 12. It should be appreciated that the louvers 36 are brazed to the top 22 and base 20 of the tube 12. It should also be appreciated that the louvers 36 extend longitudinally generally parallel to the base 34.

Referring to FIGS. 4 through 6, an apparatus, generally indicated at 40, is shown for making the turbulator 30. The apparatus 40 includes a pair of support members 42 spaced longitudinally and extending vertically. The support members 42 are secured by suitable means such

as fasteners 44 to a support surface 46. The apparatus 40 also includes a first or lower stripper plate 48 disposed adjacent the support members 42 and a second or upper stripper plate 50 disposed adjacent the lower stripper plate 48. The lower and upper stripper plates 48 and 50 are secured to the support members 42 by suitable means such as fasteners 52. The stripper plates 48 and 50 include a recess 54 being generally arcuate in shape with a plurality of channels 56 spaced laterally and extending longitudinally. In the embodiment illustrated, there are nine channels 56 spaced laterally a predetermined distance such as 0.0775 inches. The channels 56 have a predetermined width such as 0.025 inches for teeth 62 of rollers 58,60 to be described.

As illustrated in FIGS. 4 through 7, the apparatus 40 includes a pair of rotatable rollers such as an upper roller 58 and a lower roller 60 operatively connected to supporting structure (not shown). The upper roller 58 and lower roller 60 are generally circular in shape and have a plurality of teeth 62 extending radially and circumferentially and are spaced circumferentially. The upper roller 58 is disposed in the recess 54 of the upper stripper plate 50 such that a portion of the teeth 62 are disposed in the channels 56 of the upper stripper plate 50. The lower roller 60 is disposed in the recess 54 of the

lower stripper plate 58 such that a portion of the teeth 62 are disposed in the channels 56 of the lower stripper plate 48. The base 34 of the turbulator 30 is fed into a slot or channel 64 between the upper stripper plate 50 and the lower stripper plate 48 in a longitudinal direction, which is the rolling direction for the upper and lower rollers 58 and 60. It should be appreciated that the strip 31 is roll-formed to make corrugations similar to that disclosed in U.S. Patent No. 3,214,954, the disclosure of which is hereby incorporated by reference.

As illustrated in FIGS. 6 and 7, the teeth 62 of the upper and lower rollers 58 and 60 have a base-forming portion 65 and a protruding or louver-forming portion 66. The louver-forming portion 66 extends axially and radially to form the louvers 36 of the turbulator 30 in one direction. The teeth 62 also have a tooth arc 68 and a root tip 70 to form the connecting members 33 between the fins 32. The base-forming portion 65 is disposed laterally between the louver-forming portions 66 to maintain the flat shape of the base 34 of the turbulator 30. It should be appreciated that the teeth 62 of rollers 58 and 60 engage each other to form the louvers 36 of the turbulator 30 and the flat portion or base 34 between the louvers 36 provide strength and allow a finger (not shown) to strip the turbulator 30 to form a coil or roll. It should also be

appreciated that the teeth 62 of the rollers 58 and 60 engage each other to corrugate the fins 32 and form the connecting members 33 between the fins 32 while simultaneously cutting or forming the louvers 36.

The present invention has been described in an illustrative manner. It is to be understood that the terminology, which has been used, is intended to be in the nature of words of description rather than of limitation.

Many modifications and variations of the present invention are possible in light of the above teachings. Therefore, within the scope of the appended claims, the present invention may be practiced other than as specifically described.